

## Town of Otis - Shadow Flicker Methodology & Modeling

9-10-15

**Project Location:**

Algerie Rd.  
Otis, MA

**Methodology:**

This summary of methodology is presented to help provide context for how a conservative estimate of actual shadow flicker impacts at representative receptor locations was developed for the project area.

Receptor Identification

A theoretical impact model is useful to screen all receptors that are within (10) rotor diameters of the turbine location. Using theoretical maximum impact modeling, the chart in Figure 1 identifies shadow flicker receptors that receive greater than (30) shadow flicker hours per year or greater than (30) minutes per day.

**Figure 1:**

Receptor	Shadow Flicker Hours Per Year: Theoretical (hh:mm)	Shadow Flicker Hours Per Day: Theoretical (hh:mm)
SR1	91:16	1:24
SR2	31:17	0:40
SR3	34:38	0:38
SR7	17:02	0:32
SR9	17:48	0:33
SR10A	15:49	0:30
SR10	16:18	0:30
SR11	23:54	0:36
SR14	48:34	0:37
SR15	33:36	0:32

The locations of these receptors are identified in the attached shadow flicker report.

## Real-case Assessment and Methodology

The following real-case assessment was completed in order to better quantify the probable flicker effects on several nearby receptors using statistical data and modeling. In order to determine these statistical results the following inputs and methodology were used:

- Shadow flicker module of WindPRO, version 2.7.486.
- Single GE 1.7 wind turbine with a hub height of 80 meters, and a rotor diameter of 103 meters sited at the Town of Otis, MA Algeria Rd. Site.
- Virtual Met Mast provided by AWS Truepower for site wind characteristics.
- Five (5) receptors which received a theoretical shadow flicker impact greater than 30 hours per year and 30 minutes per day. The following receptors are those that exceeded this yield and used in the real case model:
  - SR1, SR2,SR3, SR14, SR15
- Five (5) receptors which received a theoretical shadow impact greater than 30 minutes per day. The following receptors are those that exceeded this yield and used in the real case model:
  - SR7, SR9, SR10, SR10A, SR11
- Publically available data for Average Percentage of Possible Sunshine from the National Oceanic and Atmospheric Administration, National Climatic Data Center ([www.ncdc.noaa.gov](http://www.ncdc.noaa.gov))
  - Average Percentage of Possible Sunshine - the total time that sunshine reaches the surface of the earth is expressed as the percentage of the maximum amount possible from sunrise to sunset with clear sky conditions<sup>1</sup>.
  - Monthly average percent possible sunshine data over a span of 113 years (1896-2009) from the Blue Hill Observatory in Milton, MA<sup>2</sup>.

Based off of the Average Percentage of Possible Sunshine data (APPS) from the Blue Hill Observatory, which is located approximately 98 miles to the east of the proposed turbine for the Town of Otis and shown in Figure 2, SED was able to determine the Average Daily Sunshine Probabilities (ADSP) per month to input into WindPRO. These calculations are shown as Figure 3. WindPRO then uses the ADSP inputs as a percentage of the potential monthly sun hours to adjust the theoretical case scenario results.

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<sup>1</sup> <http://ols.nndc.noaa.gov/plolstore/plsql/olstore.prodspcific?prodnum=C00095-PUB-A0001>

<sup>2</sup> Location was selected in consultation with Town of Charlton's third-party reviewer, VHB.

Figure 2:

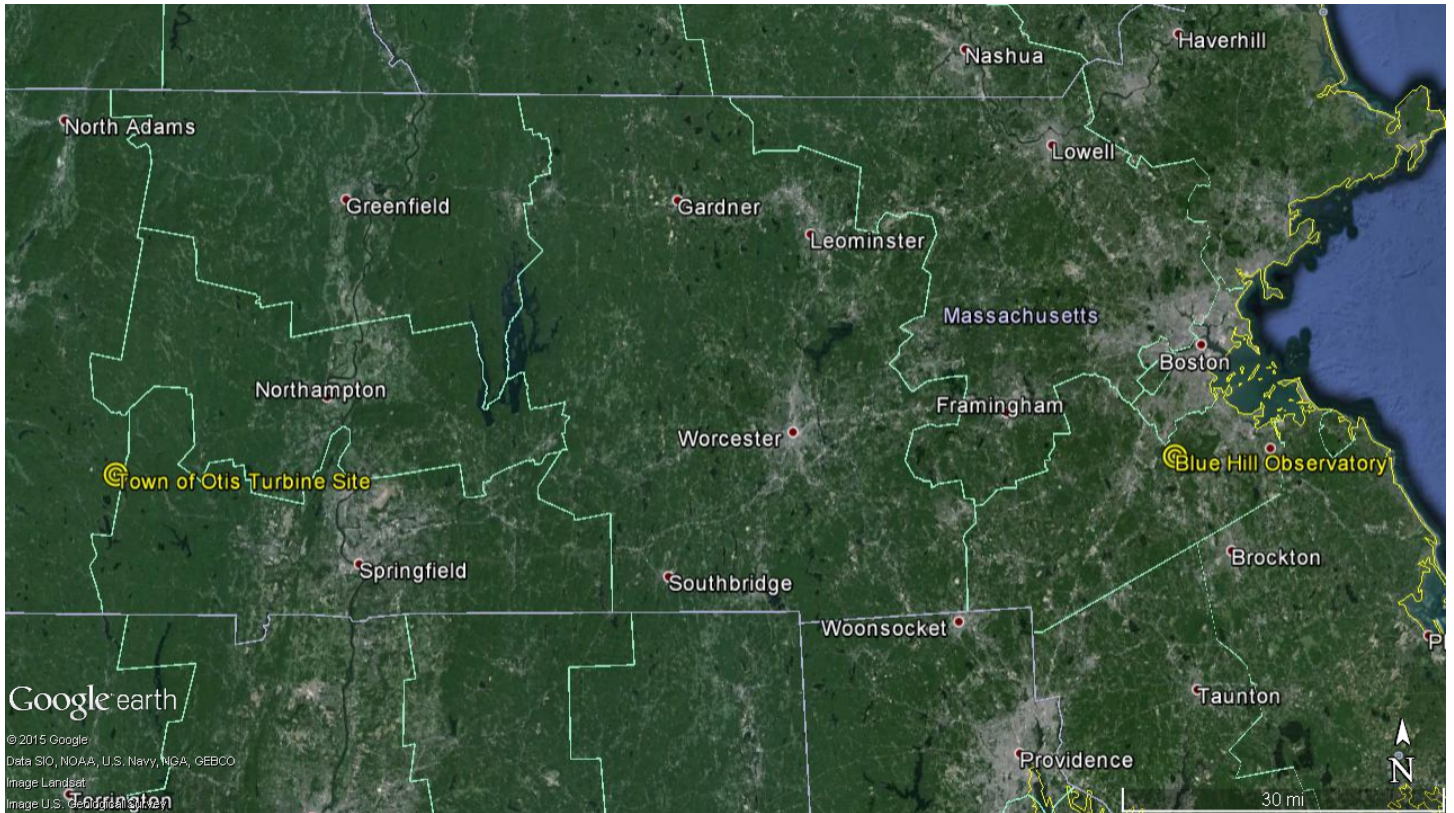


Figure 3:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>Potential Monthly Sun Hours</b>	294	296	370	400	451	456	463	430	375	344	295	284
<b>Potential Daily Sun Hours</b>	9.48	10.57	11.94	13.33	14.55	15.20	14.94	13.87	12.50	11.10	9.83	9.16
<b>Blue Hill APPS</b>	46%	50%	58%	59%	52%	55%	57%	58%	56%	55%	47%	46%
<b>ADSP Hours</b>	4.36	5.29	6.92	7.87	7.57	8.36	8.51	8.05	7.00	6.10	4.62	4.21

Long term correlated data from the 80m Virtual Met Mast was also used to determine the wind distribution and operating time for the proposed wind turbines. This gives the model the probable hours of operation for

each wind-direction sector. Once the above data was entered into WindPRO and real case shadow flicker model was ran, the following flicker impacts resulted at the identified receptors:

**Figure 4:**

<b>Receptor</b>	<b>Shadow Flicker Hours Per Year: Real Case (hh:mm)</b>
SR1	26:11
SR2	10:55
SR3	11:25
SR7	6:50
SR9	7:09
SR10A	6:19
SR10	6:29
SR11	9:24
SR14	17:10
SR15	11:02

The WindPRO report is attached and includes the main report outlining the results.

The results in the attached shadow flicker model should be considered conservative, as they do not account for any obstructions between the turbine site and receptor location, such as trees. It should be considered that the area encompassing the turbine site and receptor locations is heavily forested. Any shading caused by these obstructions, in direct line of sight between the turbine site and receptor location, will further reduce the shadow flicker effect at these receptors.

Project: Description:  
**Otis** Real Case Shadow Flicker Assessment for Town of Otis - Algeria Rd. Site  
 GE 1.7 103m Rotor 80m Hub  
 Real Case Statistics:  
 Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)  
 APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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 9/3/2015 1:59 PM/2.7.486

**SHADOW - Main Result**

Calculation: Otis Shadow Flicker - Algeria Rd. REAL CASE

**Assumptions for shadow calculations**

Maximum distance for influence  
 Calculate only when more than 20 % of sun is covered by the blade  
 Please look in WTG table

Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []  
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21

Operational hours are calculated from WTGs in calculation and wind distribution:  
 WS Met Mast VMM Alternate Site

Operational time  
 N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367  
 Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used: DEM  
 Obstacles used in calculation  
 Eye height: 1.5 m  
 Grid resolution: 10 m



Scale 1:7,500  
 New WTG Shadow receptor

**WTGs**

UTM WGS84 Zone: 18				WTG type			Shadow data				
East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
662,915	4,676,722	499.3	GE 1.7 103m Rotor 80m Hub	Yes	GE WIND ENERGY	GE 1.7-1,700	1,700	103.0	80.0	2,000	0.0

**Shadow receptor-Input**

UTM WGS84 Zone: 18										
No.	Name	East	North	Z	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	SR1	662,753	4,676,952	517.1	1.0	1.0	1.5	-180.0	90.0	"Green house mode"
B	SR3	662,356	4,677,065	486.4	1.0	1.0	1.5	-180.0	90.0	"Green house mode"
C	SR2	662,371	4,676,988	484.3	1.0	1.0	1.5	-180.0	90.0	"Green house mode"
D	SR7	662,180	4,676,810	480.0	1.0	1.0	1.5	-180.0	90.0	"Green house mode"
E	SR9	662,189	4,676,757	480.0	1.0	1.0	1.5	-180.0	90.0	"Green house mode"
F	SR10A	662,124	4,676,664	480.0	1.0	1.0	1.5	-180.0	90.0	"Green house mode"
G	SR10	662,125	4,676,620	480.0	1.0	1.0	1.5	-180.0	90.0	"Green house mode"
H	SR11	662,242	4,676,603	480.0	1.0	1.0	1.5	-180.0	90.0	"Green house mode"
I	SR14	662,279	4,676,466	479.9	1.0	1.0	1.5	-180.0	90.0	"Green house mode"
J	SR15	662,168	4,676,430	477.6	1.0	1.0	1.5	-180.0	90.0	"Green house mode"

**Calculation Results**

Shadow receptor

Shadow, expected values	
No.	Name
A	SR1
B	SR3
C	SR2
D	SR7
E	SR9
F	SR10A
G	SR10
H	SR11
I	SR14
J	SR15

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	GE 1.7 103m Rotor 80m Hub	263:19	88:57

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**SHADOW - Calendar**

Calculation: Otis Shadow Flicker - Algeria Rd. REAL CASE Shadow receptor: A - SR1

**Assumptions for shadow calculations**

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []  
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21

Operational time  
 N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June	July	August	September	October	November	December	
1	07:22 16:31 82	08:42 (1)   07:07 10:04 (1)   17:06	06:29 17:42	06:37 19:18	05:49 19:51	05:19 20:21	05:20 20:33	05:45 20:14	06:17 19:28	06:49 18:35	06:25 16:47	07:01 16:22 75	08:31 (1) 09:46 (1)
2	07:22 16:32 82	08:42 (1)   07:06 10:04 (1)   17:07	06:28 17:43	06:35 19:19	05:48 19:52	05:19 20:22	05:20 20:33	05:46 20:13	06:18 19:26	06:50 18:34	06:26 16:46	07:02 16:21 76	08:31 (1) 09:47 (1)
3	07:22 16:32 81	08:43 (1)   07:05 10:04 (1)   17:09	06:26 17:44	06:33 19:20	05:46 19:53	05:18 20:23	05:21 20:33	05:47 20:12	06:19 19:24	06:51 18:32	06:27 16:45	07:03 16:21 76	08:31 (1) 09:47 (1)
4	07:22 16:33 80	08:44 (1)   07:04 10:04 (1)   17:10	06:24 17:45	06:31 19:21	05:45 19:54	05:18 20:23	05:21 20:33	05:48 20:10	06:20 19:23	06:52 18:30	06:29 16:43	07:04 16:21 77	08:31 (1) 09:48 (1)
5	07:22 16:34 80	08:44 (1)   07:02 10:04 (1)   17:11	06:23 17:47	06:30 19:22	05:44 19:56	05:17 20:24	05:22 20:32	05:49 20:09	06:21 19:21	06:53 18:29	06:30 16:42	07:05 16:21 78	08:31 (1) 09:49 (1)
6	07:22 16:35 79	08:45 (1)   07:01 10:04 (1)   17:13	06:21 17:48	06:28 19:23	05:43 19:57	05:17 20:25	05:22 20:32	05:50 20:08	06:22 19:19	06:54 18:27	06:31 16:41	07:06 16:21 79	08:31 (1) 09:50 (1)
7	07:22 16:36 79	08:45 (1)   07:00 10:04 (1)   17:14	06:19 17:49	06:26 19:24	05:41 19:58	05:17 20:26	05:23 20:32	05:51 20:07	06:23 19:18	06:55 18:25	06:32 16:40	07:07 16:20 80	08:31 (1) 09:51 (1)
8	07:21 16:37 78	08:46 (1)   06:59 10:04 (1)   17:15	07:18 18:50	06:25 19:25	05:40 19:59	05:17 20:26	05:24 20:32	05:52 20:05	06:24 19:16	06:57 18:24	06:34 16:39	07:08 16:20 80	08:31 (1) 09:51 (1)
9	07:21 16:38 76	08:48 (1)   06:58 10:04 (1)   17:17	07:16 18:51	06:23 19:27	05:39 20:00	05:16 20:27	05:24 20:31	05:53 20:04	06:25 19:14	06:58 18:22	06:35 16:38	07:09 16:20 81	08:31 (1) 09:52 (1)
10	07:21 16:39 76	08:48 (1)   06:57 10:04 (1)   17:18	07:14 18:53	06:21 19:28	05:38 20:00	05:16 20:27	05:25 20:31	05:54 20:03	06:27 19:12	06:59 18:20	06:36 16:37	07:10 16:20 81	08:32 (1) 09:53 (1)
11	07:21 16:40 75	08:49 (1)   06:55 10:04 (1)   17:19	07:13 18:54	06:20 19:29	05:37 20:01	05:16 20:28	05:26 20:30	05:55 20:01	06:28 19:11	07:00 18:19	06:37 16:36	07:11 16:20 82	08:32 (1) 09:54 (1)
12	07:20 16:42 74	08:50 (1)   06:54 10:04 (1)   17:20	07:11 18:55	06:18 19:30	05:36 20:02	05:16 20:29	05:27 20:30	05:56 20:00	06:29 19:09	07:01 18:17	06:38 16:35	07:12 09:10 (1) 18	08:32 (1) 09:55 (1)
13	07:20 16:43 73	08:50 (1)   06:53 10:03 (1)   17:22	07:09 18:56	06:16 19:31	05:34 20:03	05:16 20:29	05:27 20:29	05:57 19:57	06:30 19:07	07:02 18:15	06:40 16:34	07:12 09:15 (1) 27	08:32 (1) 09:54 (1)
14	07:20 16:44 71	08:52 (1)   06:51 10:03 (1)   17:23	07:08 18:57	06:15 19:32	05:33 20:04	05:16 20:30	05:28 20:29	05:58 19:56	06:31 19:05	07:03 18:14	06:41 16:33	07:13 09:18 (1) 33	08:32 (1) 09:55 (1)
15	07:19 16:45 70	08:52 (1)   06:50 10:02 (1)   17:24	07:06 18:58	06:13 19:33	05:32 20:05	05:16 20:30	05:29 20:28	05:59 19:55	06:32 19:04	07:04 18:12	06:42 16:32	07:14 09:21 (1) 39	08:33 (1) 09:56 (1)
16	07:19 16:46 68	08:54 (1)   06:49 10:02 (1)   17:26	07:04 19:00	06:12 19:34	05:31 20:06	05:16 20:30	05:30 20:28	06:00 19:53	06:33 19:02	07:06 18:10	06:43 16:31	07:15 09:24 (1) 43	08:34 (1) 09:57 (1)
17	07:18 16:47 67	08:54 (1)   06:47 10:01 (1)   17:27	07:02 19:01	06:10 19:36	05:30 20:07	05:16 20:31	05:31 20:27	06:01 19:52	06:34 19:00	07:07 18:09	06:45 16:30	07:15 09:26 (1) 47	08:33 (1) 09:57 (1)
18	07:18 16:49 65	08:56 (1)   06:46 10:01 (1)   17:28	07:01 19:02	06:08 19:37	05:29 20:08	05:16 20:31	05:31 20:26	06:02 19:50	06:35 18:58	07:08 18:07	06:46 16:29	07:16 09:28 (1) 50	08:34 (1) 09:58 (1)
19	07:17 16:50 63	08:57 (1)   06:44 10:00 (1)   17:29	06:59 19:03	06:07 19:38	05:28 20:09	05:16 20:32	05:32 20:26	06:03 19:49	06:36 18:57	07:09 18:06	06:47 16:28	07:17 09:30 (1) 54	08:35 (1) 09:59 (1)
20	07:17 16:51 61	08:58 (1)   06:43 09:59 (1)   17:31	06:57 19:04	06:05 19:39	05:28 20:10	05:16 20:32	05:33 20:25	06:04 19:47	06:37 18:55	07:10 18:04	06:48 16:28	07:17 09:32 (1) 56	08:35 (1) 09:59 (1)
21	07:16 16:52 59	08:59 (1)   06:41 09:58 (1)   17:32	06:56 19:05	06:04 19:40	05:27 20:11	05:16 20:32	05:34 20:24	06:06 19:46	06:38 18:53	07:11 18:03	06:50 16:27	07:18 09:34 (1) 59	08:36 (1) 10:00 (1)
22	07:15 16:53 56	09:01 (1)   06:40 09:57 (1)   17:33	06:54 19:06	06:02 19:41	05:26 20:12	05:16 20:32	05:35 20:23	06:07 19:44	06:39 18:51	07:13 18:01	06:51 16:26	07:18 09:35 (1) 61	08:36 (1) 10:00 (1)
23	07:15 16:55 54	09:02 (1)   06:38 09:56 (1)   17:34	06:52 19:07	06:01 19:42	05:25 20:13	05:17 20:33	05:36 20:23	06:08 19:42	06:40 18:49	07:14 18:00	06:52 16:26	07:19 09:37 (1) 63	08:37 (1) 10:01 (1)
24	07:14 16:56 50	09:04 (1)   06:37 09:54 (1)   17:36	06:50 19:09	05:59 19:43	05:24 20:14	05:17 20:33	05:37 20:22	06:09 19:41	06:41 18:48	07:15 17:58	06:53 16:25	07:19 09:38 (1) 65	08:37 (1) 10:01 (1)
25	07:13 16:57 47	09:05 (1)   06:35 09:52 (1)   17:37	06:49 19:10	05:58 19:44	05:23 20:15	05:17 20:33	05:38 20:21	06:10 19:39	06:42 18:46	07:16 17:57	06:54 16:24	07:20 09:39 (1) 67	08:37 (1) 10:01 (1)
26	07:12 16:58 43	09:07 (1)   06:34 09:50 (1)   17:38	06:47 19:11	05:56 19:46	05:23 20:16	05:17 20:33	05:39 20:20	06:11 19:38	06:43 18:44	07:17 17:55	06:55 16:24	07:20 09:40 (1) 68	08:38 (1) 10:02 (1)
27	07:11 17:00 38	09:11 (1)   06:32 09:49 (1)   17:39	06:45 19:12	05:55 19:47	05:22 20:17	05:18 20:33	05:40 20:19	06:12 19:36	06:44 18:42	07:19 17:54	06:57 16:23	07:20 09:41 (1) 70	08:38 (1) 10:02 (1)
28	07:11 17:01 33	09:13 (1)   06:31 09:46 (1)   17:41	06:43 19:13	05:53 19:48	05:21 20:18	05:18 20:33	05:41 20:18	06:13 19:34	06:46 18:41	07:20 17:53	06:58 16:23	07:21 09:43 (1) 71	08:39 (1) 10:02 (1)
29	07:10 17:02 27	09:16 (1)   09:43 (1)   17:41	06:42 19:14	05:52 19:49	05:21 20:19	05:19 20:33	05:42 20:17	06:14 19:33	06:47 18:39	07:21 17:51	06:59 16:22	07:21 09:44 (1) 73	08:39 (1) 10:02 (1)
30	07:09 17:04 17	09:21 (1)   09:38 (1)	06:40 19:15	05:51 19:50	05:20 20:19	05:19 20:33	05:43 20:16	06:15 19:31	06:48 18:37	07:22 17:50	07:00 16:22	07:21 09:45 (1) 74	08:40 (1) 10:02 (1)
31	07:08 17:05	06:38 19:16	05:20 20:20	05:44 19:29	06:16 17:48	07:24 16:30	07:21 16:30 83	07:21 16:30 83	07:21 16:30 83	07:21 16:30 83	07:21 16:30 83	07:21 16:30 83	08:41 (1) 10:04 (1)
Potential sun hours	294	296	370	401	451	456	463	430	375	344	295	284	
Total, worst case	1904										1038	2534	
Sun reduction	0.46										0.47	0.46	
Oper. time red.	0.96										0.96	0.96	
Wind dir. red.	0.65										0.65	0.65	
Total reduction	0.29										0.29	0.29	
Total, real	544										303	724	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

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**SHADOW - Calendar**

Calculation: Otis Shadow Flicker - Algeria Rd. REAL CASE Shadow receptor: B - SR3

**Assumptions for shadow calculations**

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []  
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21

Operational time  
 N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June	July	August	September	October	November	December	
1	07:22 16:31	07:07 17:06	07:43 (1) 08:20 (1)	06:29 17:42	06:37 19:18	05:49 20:21	05:19 20:33	05:20 20:14	05:45 19:28	06:17 18:36	06:49 16:47	07:01 16:22	07:28 (1) 18 07:46 (1)
2	07:22 16:32	07:06 17:07	07:42 (1) 08:19 (1)	06:28 17:43	06:35 19:19	05:48 20:22	05:19 20:33	05:20 20:13	05:46 19:26	06:18 18:34	06:50 16:46	07:02 16:21	07:30 (1) 15 07:45 (1)
3	07:22 16:32	07:05 17:09	07:43 (1) 08:19 (1)	06:26 17:44	06:33 19:20	05:47 20:23	05:18 20:33	05:21 20:12	05:47 19:24	06:19 18:32	06:51 16:45	07:03 16:21	07:32 (1) 12 07:44 (1)
4	07:22 16:33	07:04 17:10	07:44 (1) 08:19 (1)	06:24 17:45	06:31 19:21	05:45 20:23	05:18 20:33	05:21 20:10	05:48 19:23	06:20 18:30	06:52 16:43	07:04 16:21	07:34 (1) 8 07:42 (1)
5	07:22 16:34	07:03 17:11	07:45 (1) 08:18 (1)	06:23 17:47	06:30 19:22	05:44 20:24	05:17 20:32	05:22 20:09	05:49 19:21	06:21 18:29	06:53 16:42	07:05 16:21	
6	07:22 16:35	07:01 17:13	07:46 (1) 08:18 (1)	06:21 17:48	06:28 19:23	05:43 20:25	05:17 20:32	05:50 20:08	06:22 19:19	06:54 18:27	07:06 16:41	07:06 16:21	
7	07:22 16:36	07:00 17:14	07:47 (1) 08:18 (1)	06:19 17:49	06:26 19:24	05:41 20:26	05:17 20:32	05:51 20:07	06:23 19:18	06:55 18:25	07:07 16:40	07:07 16:20	
8	07:21 16:37	07:50 (1) 07:58 (1)	06:59 17:15	07:47 (1) 08:16 (1)	07:18 18:50	06:25 19:25	05:17 20:26	05:24 20:05	05:52 19:16	06:24 18:24	06:57 16:39	07:08 16:20	
9	07:21 16:38	07:49 (1) 08:01 (1)	06:58 17:17	07:49 (1) 08:15 (1)	07:16 18:51	06:23 19:27	05:16 20:27	05:24 20:04	05:53 19:14	06:26 18:22	06:58 16:38	07:09 16:20	
10	07:21 16:39	07:47 (1) 08:02 (1)	06:57 17:18	07:50 (1) 08:14 (1)	07:14 18:53	06:21 19:28	05:16 20:27	05:25 20:03	06:27 19:12	06:59 18:20	07:10 16:37	07:10 16:20	
11	07:21 16:40	07:46 (1) 08:04 (1)	06:55 17:19	07:53 (1) 08:12 (1)	07:13 18:54	06:20 19:29	05:16 20:28	05:26 20:02	06:28 19:11	07:00 18:19	07:11 16:36	07:11 16:20	
12	07:20 16:42	07:46 (1) 08:06 (1)	06:54 17:20	07:54 (1) 08:09 (1)	07:11 18:55	06:18 20:02	05:16 20:29	05:27 20:00	06:29 19:09	07:01 18:17	07:12 16:35	07:12 16:21	
13	07:20 16:43	07:45 (1) 08:07 (1)	06:53 17:22	08:00 (1) 08:03 (1)	07:09 18:56	06:16 19:31	05:16 20:29	05:27 20:29	06:30 19:07	07:02 18:15	07:12 16:34	07:12 16:21	
14	07:20 16:44	07:45 (1) 08:09 (1)	06:51 17:23	07:08 18:57	06:15 19:32	05:33 20:04	05:16 20:29	05:28 19:56	06:31 19:05	07:03 18:14	07:13 16:33	07:13 16:21	
15	07:19 16:45	07:44 (1) 08:09 (1)	06:50 17:24	07:06 18:58	06:13 19:33	05:32 20:05	05:16 20:30	05:29 20:28	06:32 19:55	07:04 18:12	07:14 16:32	07:14 16:21	
16	07:19 16:46	07:44 (1) 08:11 (1)	06:49 17:26	07:04 19:00	06:12 19:34	05:31 20:06	05:16 20:30	06:00 20:28	06:33 19:53	07:06 18:10	07:15 16:31	07:15 16:21	
17	07:18 16:47	07:43 (1) 08:12 (1)	06:47 17:27	07:03 19:01	06:10 19:36	05:30 20:07	05:16 20:31	06:01 20:27	06:34 19:52	07:07 18:09	07:15 16:30	07:15 16:22	
18	07:18 16:49	07:43 (1) 08:13 (1)	06:46 17:28	07:01 19:02	06:08 19:37	05:29 20:08	05:16 20:31	06:02 20:26	06:35 19:50	07:08 18:07	07:16 16:29	07:16 16:22	
19	07:17 16:50	07:42 (1) 08:14 (1)	06:44 17:29	06:59 19:03	06:07 19:38	05:28 20:09	05:16 20:32	06:03 19:49	06:36 18:57	07:09 18:06	07:17 16:28	07:17 16:22	
20	07:17 16:51	07:42 (1) 08:15 (1)	06:43 17:31	06:57 19:04	06:05 19:39	05:28 20:10	05:16 20:32	06:04 19:47	06:37 18:55	07:10 18:04	07:17 16:28	07:17 16:23	
21	07:16 16:52	07:42 (1) 08:16 (1)	06:41 17:32	06:56 19:05	06:04 19:40	05:27 20:11	05:16 20:32	06:06 19:46	06:38 18:53	07:11 18:03	07:18 16:27	07:18 16:23	
22	07:15 16:53	07:42 (1) 08:17 (1)	06:40 17:33	06:54 19:06	06:02 19:41	05:26 20:12	05:16 20:32	06:07 19:44	06:39 18:51	07:13 18:01	07:18 16:26	07:18 16:24	
23	07:15 16:55	07:41 (1) 08:17 (1)	06:39 17:34	06:52 19:08	06:01 19:42	05:25 20:13	05:17 20:33	06:08 19:42	06:40 18:49	07:14 18:00	07:19 16:26	07:19 16:24	
24	07:14 16:56	07:41 (1) 08:17 (1)	06:37 17:36	06:50 19:09	05:59 19:43	05:24 20:14	05:17 20:33	06:09 19:41	06:41 18:48	07:15 17:58	07:19 16:25	07:19 16:25	
25	07:13 16:57	07:41 (1) 08:18 (1)	06:35 17:37	06:49 19:10	05:58 19:44	05:23 20:15	05:17 20:33	06:10 20:21	06:42 19:39	07:16 18:46	07:20 16:24	07:20 16:25	
26	07:12 16:58	07:41 (1) 08:18 (1)	06:34 17:38	06:47 19:11	05:56 19:46	05:23 20:16	05:17 20:33	06:11 20:20	06:43 19:38	07:17 17:55	07:20 16:24	07:20 16:26	
27	07:11 17:00	07:42 (1) 08:19 (1)	06:32 17:39	06:45 19:12	05:55 19:47	05:22 20:17	05:18 20:33	06:12 20:19	06:44 19:36	07:19 18:42	07:20 16:23	07:20 16:27	
28	07:11 17:01	07:42 (1) 08:20 (1)	06:31 17:41	06:43 19:13	05:53 19:48	05:21 20:18	05:18 20:33	06:13 19:34	06:46 18:41	07:20 17:53	07:21 16:23	07:21 16:27	
29	07:10 17:02	07:42 (1) 08:20 (1)	06:41 17:41	06:42 19:14	05:52 19:49	05:19 20:19	05:19 20:33	06:14 20:17	06:47 19:33	07:21 17:51	07:21 16:22	07:21 16:28	
30	07:09 17:04	07:42 (1) 08:20 (1)	06:39 17:41	06:40 19:15	05:51 19:50	05:20 20:20	05:19 20:33	06:15 19:31	06:48 18:37	07:22 17:50	07:22 16:22	07:22 16:29	
31	07:08 17:05	07:43 (1) 08:20 (1)	06:38 17:41	06:38 19:17	05:20 20:20	05:20 20:20	05:44 20:15	06:16 19:29	07:24 17:48	08:21 (1) 20 08:41 (1)	07:24 16:30	07:24 16:30	
Potential sun hours	294	296	370	401	451	456	463	430	375	344	295	284	
Total, worst case	698	357								42	970	53	
Sun reduction	0.46	0.50								0.55	0.47	0.46	
Oper. time red.	0.96	0.96								0.96	0.96	0.96	
Wind dir. red.	0.72	0.72								0.72	0.72	0.72	
Total reduction	0.31	0.34								0.38	0.32	0.31	
Total, real	219	122								16	312	17	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project: **Otis** Description: Real Case Shadow Flicker Assessment for Town of Otis - Algeria Rd. Site  
 GE 1.7 103m Rotor 80m Hub  
 Real Case Statistics:  
 Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)  
 APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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 US-14519 Ontario, NY  
 4738  
 Scott Abbett / scott.abbett@sed-net.com  
 Calculated: 9/3/2015 1:59 PM/2.7.486

**SHADOW - Calendar**

Calculation: Otis Shadow Flicker - Algeria Rd. REAL CASE Shadow receptor: C - SR2

**Assumptions for shadow calculations**

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []  
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21

Operational time  
 N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June	July	August	September	October	November	December		
1	07:22 16:31	07:07 17:06	07:33 (1) 08:01 (1)	06:29 17:42	06:37 19:18	05:49 19:51	05:19 20:21	05:20 20:33	05:45 20:14	06:17 19:28	06:49 18:35	06:25 16:47	06:58 (1) 07:37 (1)	07:01 16:22
2	07:22 16:32	07:06 17:07	07:31 (1) 08:01 (1)	06:28 17:43	06:35 19:19	05:48 19:52	05:19 20:22	05:20 20:33	05:46 20:13	06:18 19:26	06:50 18:34	06:26 16:46	06:58 (1) 07:37 (1)	07:02 16:21
3	07:22 16:32	07:05 17:09	07:31 (1) 08:03 (1)	06:26 17:44	06:33 19:20	05:47 19:53	05:18 20:23	05:21 20:33	05:47 20:12	06:19 19:24	06:51 18:32	06:27 16:45	06:58 (1) 07:36 (1)	07:03 16:21
4	07:22 16:33	07:04 17:10	07:30 (1) 08:04 (1)	06:24 17:45	06:31 19:21	05:45 19:54	05:18 20:23	05:21 20:33	05:48 20:10	06:20 19:23	06:52 18:30	06:29 16:43	06:59 (1) 07:36 (1)	07:04 16:21
5	07:22 16:34	07:03 17:11	07:30 (1) 08:05 (1)	06:23 17:47	06:30 19:22	05:44 19:56	05:17 20:24	05:22 20:32	05:49 20:09	06:21 19:21	06:53 18:29	06:30 16:42	06:59 (1) 07:35 (1)	07:05 16:21
6	07:22 16:35	07:01 17:13	07:29 (1) 08:06 (1)	06:21 17:48	06:28 19:23	05:43 19:57	05:17 20:25	05:22 20:32	05:50 20:08	06:22 19:19	06:54 18:27	06:31 16:41	06:59 (1) 07:34 (1)	07:06 16:21
7	07:22 16:36	07:00 17:14	07:29 (1) 08:07 (1)	06:19 17:49	06:26 19:24	05:41 19:58	05:17 20:26	05:23 20:32	05:51 20:07	06:23 19:18	06:55 18:25	06:32 16:40	07:01 (1) 07:34 (1)	07:07 16:20
8	07:21 16:37	06:59 17:15	07:28 (1) 08:06 (1)	07:18 18:50	06:25 19:25	05:40 19:59	05:17 20:26	05:24 20:32	05:52 20:05	06:24 19:16	06:57 18:24	06:34 16:39	07:02 (1) 07:33 (1)	07:08 16:20
9	07:21 16:38	06:58 17:17	07:28 (1) 08:07 (1)	07:16 18:51	06:23 19:27	05:39 20:00	05:16 20:27	05:24 20:31	05:53 20:03	06:26 19:12	06:58 18:20	06:35 16:37	07:02 (1) 07:34 (1)	07:09 16:20
10	07:21 16:39	06:57 17:18	07:28 (1) 08:07 (1)	07:14 18:53	06:21 19:28	05:38 20:00	05:16 20:27	05:25 20:31	05:54 20:03	06:27 19:12	06:59 18:20	06:36 16:37	07:04 (1) 07:34 (1)	07:10 16:20
11	07:21 16:40	06:55 17:19	07:28 (1) 08:08 (1)	07:13 18:54	06:20 19:29	05:37 20:01	05:16 20:28	05:26 20:30	05:55 20:02	06:28 19:11	07:00 18:19	06:37 16:36	07:05 (1) 07:30 (1)	07:11 16:20
12	07:20 16:42	06:54 17:20	07:27 (1) 08:07 (1)	07:11 18:55	06:18 19:30	05:36 20:02	05:16 20:29	05:27 20:30	05:56 20:00	06:29 19:09	07:01 18:17	06:39 16:35	07:07 (1) 07:28 (1)	07:12 16:21
13	07:20 16:43	06:53 17:22	07:28 (1) 08:08 (1)	07:09 18:56	06:16 19:31	05:34 20:03	05:16 20:29	05:27 20:29	05:57 19:57	06:30 19:07	07:02 18:15	06:40 16:34	07:10 (1) 07:27 (1)	07:12 16:21
14	07:20 16:44	06:51 17:23	07:28 (1) 08:08 (1)	07:08 18:57	06:15 19:32	05:33 20:04	05:16 20:30	05:28 20:29	05:58 19:56	06:31 19:05	07:03 18:14	06:41 16:33	07:12 (1) 07:24 (1)	07:13 16:21
15	07:19 16:45	06:50 17:24	07:28 (1) 08:07 (1)	07:06 18:58	06:13 19:33	05:32 20:05	05:16 20:30	05:29 20:28	05:59 19:55	06:32 19:04	07:04 18:12	06:42 16:32	07:14 (1) 07:15	07:14 16:21
16	07:19 16:46	06:49 17:26	07:29 (1) 08:07 (1)	07:04 19:00	06:12 19:34	05:31 20:06	05:16 20:30	06:00 20:28	06:33 19:53	07:06 19:02	07:06 18:10	06:43 16:31	07:15 (1) 08:09 (1)	07:15 16:21
17	07:18 16:47	06:47 17:27	07:28 (1) 08:06 (1)	07:03 19:01	06:10 19:36	05:30 20:07	05:16 20:31	06:01 20:27	06:34 19:52	07:07 19:00	07:07 18:09	06:45 16:30	07:16 (1) 08:07 (1)	07:16 16:22
18	07:18 16:49	06:46 17:28	07:29 (1) 08:06 (1)	07:01 19:02	06:08 19:37	05:29 20:08	05:16 20:31	06:02 20:26	06:35 19:50	07:08 18:58	07:08 18:07	06:46 16:29	07:17 (1) 08:29 (1)	07:17 16:22
19	07:17 16:50	06:44 17:29	07:30 (1) 08:04 (1)	06:59 19:03	06:07 19:38	05:28 20:09	05:16 20:32	06:03 20:26	06:36 19:49	07:09 18:57	07:09 18:06	06:47 16:28	07:18 (1) 08:31 (1)	07:18 16:22
20	07:17 16:51	06:43 17:31	07:31 (1) 08:04 (1)	06:57 19:04	06:05 19:39	05:28 20:10	05:16 20:32	06:04 19:47	06:37 18:55	07:10 18:04	07:10 18:04	06:48 16:28	07:19 (1) 08:32 (1)	07:17 16:23
21	07:16 16:52	06:41 17:32	07:31 (1) 08:02 (1)	06:56 19:05	06:04 19:40	05:27 20:11	05:16 20:32	06:06 20:24	06:38 19:46	07:11 18:53	07:11 18:03	06:50 16:27	07:18 (1) 08:33 (1)	07:18 16:23
22	07:15 16:53	06:40 17:33	07:33 (1) 08:01 (1)	06:54 19:06	06:02 19:41	05:26 20:12	05:16 20:32	06:07 20:23	06:39 19:44	07:13 18:51	07:13 18:01	06:51 16:26	07:19 (1) 08:00 (1)	07:18 16:24
23	07:15 16:55	06:39 17:34	07:34 (1) 07:59 (1)	06:52 19:08	06:01 19:42	05:25 20:13	05:17 20:33	06:08 19:42	06:40 18:49	07:14 18:00	07:14 18:00	06:52 16:26	07:20 (1) 08:35 (1)	07:19 16:24
24	07:14 16:56	06:37 17:36	07:36 (1) 07:57 (1)	06:50 19:09	05:59 19:43	05:24 20:14	05:17 20:33	06:09 20:22	06:41 19:41	07:15 18:48	07:15 17:58	06:53 16:25	07:21 (1) 08:35 (1)	07:19 16:25
25	07:13 16:57	06:35 17:37	07:39 (1) 07:54 (1)	06:49 19:10	05:58 19:44	05:23 20:15	05:17 20:33	06:10 20:21	06:42 19:39	07:16 18:46	07:16 17:57	06:54 16:24	07:22 (1) 07:57 (1)	07:20 16:25
26	07:12 16:58	06:34 17:38	06:47 19:11	06:47 19:46	05:56 20:16	05:23 20:33	05:17 20:20	06:11 19:38	06:43 18:44	07:17 17:55	07:17 17:55	06:55 16:24	07:23 (1) 08:37 (1)	07:20 16:26
27	07:11 17:00	06:32 17:39	06:45 19:12	06:45 19:47	05:55 20:17	05:22 20:33	05:18 20:19	06:12 19:36	06:44 18:42	07:19 17:54	07:19 17:54	06:57 16:23	07:24 (1) 08:37 (1)	07:20 16:27
28	07:11 17:01	06:31 07:40 (1)	06:43 19:13	06:43 19:48	05:53 20:18	05:21 20:33	05:18 20:18	06:13 19:34	06:46 18:41	07:20 17:53	07:20 17:53	06:58 16:23	07:25 (1) 08:37 (1)	07:21 16:27
29	07:10 17:02	06:38 (1) 07:55 (1)	06:42 19:14	06:42 19:49	05:52 20:19	05:21 20:33	05:19 20:17	06:14 19:33	06:47 18:39	07:21 17:51	07:21 17:51	06:59 16:22	07:26 (1) 08:37 (1)	07:21 16:28
30	07:09 17:04	06:36 (1) 07:58 (1)	06:40 19:15	06:40 19:50	05:51 20:20	05:20 20:33	05:19 20:16	06:15 19:31	06:48 18:37	07:22 17:50	07:22 17:50	07:00 16:22	07:27 (1) 08:37 (1)	07:21 16:29
31	07:08 17:05	06:34 (1) 07:59 (1)	06:38 19:17	06:38 19:47	05:50 20:20	05:19 20:33	05:18 20:15	06:16 19:29	06:49 18:46	07:24 17:48	07:24 17:48	07:21 16:30	07:28 (1) 08:37 (1)	07:21 16:30
Potential sun hours	294	296	370	401	451	456	463	430	375	344	295	284		
Total, worst case	76	849									517	421		
Sun reduction	0.46	0.50									0.55	0.47		
Oper. time red.	0.96	0.96									0.96	0.96		
Wind dir. red.	0.73	0.73									0.73	0.73		
Total reduction	0.32	0.35									0.38	0.33		
Total, real	24	296									198	138		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)





Project: Otis
Description: Real Case Shadow Flicker Assessment for Town of Otis - Algeria Rd. Site
GE 1.7 103m Rotor 80m Hub
Real Case Statistics:
Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)
APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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Scott Abbett / scott.abbett@sed-net.com
Calculated: 9/3/2015 1:59 PM/2.7.486

SHADOW - Calendar

Calculation: Otis Shadow Flicker - Algeria Rd. REAL CASE Shadow receptor: E - SR9

Assumptions for shadow calculations

Maximum distance for influence 2,000 m
Minimum sun height over horizon for influence 3 °
Day step for calculation 1 days
Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21

Operational time
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum
442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367
Idle start wind speed: Cut in wind speed from power curve

Table with columns for months (January to December) and rows for days (1-31) showing sun rise/set times and potential sun hours. Summary rows include Total, worst case, Sun reduction, Oper. time red., Wind dir. red., Total reduction, and Total, real.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

Project: Otis
Description: Real Case Shadow Flicker Assessment for Town of Otis - Algeria Rd. Site
GE 1.7 103m Rotor 80m Hub
Real Case Statistics:
Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)
APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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US-14519 Ontario, NY
4738
Scott Abbett / scott.abbett@sed-net.com
Calculated: 9/3/2015 1:59 PM/2.7.486

SHADOW - Calendar

Calculation: Otis Shadow Flicker - Algeria Rd. REAL CASE Shadow receptor: F - SR10A

Assumptions for shadow calculations

Maximum distance for influence: 2,000 m
Minimum sun height over horizon for influence: 3 °
Day step for calculation: 1 days
Time step for calculation: 1 minutes

Sunshine probability S (Average daily sunshine hours) []
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21

Operational time
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum
442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367
Idle start wind speed: Cut in wind speed from power curve

Table with 12 columns for months (January-December) and rows for each day (1-31) showing sun rise/set times and potential sun hours. Summary rows at the bottom show Total, worst case, Sun reduction, Oper. time red., Wind dir. red., Total reduction, and Total, real.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

Project: Otis Real Case Shadow Flicker Assessment for Town of Otis - Algerie Rd. Site
Description: GE 1.7 103m Rotor 80m Hub
Real Case Statistics: Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)
APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)
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Scott Abbett / scott.abbett@sed-net.com
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SHADOW - Calendar

Calculation: Otis Shadow Flicker - Algerie Rd. REAL CASE Shadow receptor: G - SR10

Assumptions for shadow calculations

Maximum distance for influence 2,000 m
Minimum sun height over horizon for influence 3 °
Day step for calculation 1 days
Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21

Operational time
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum
442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367
Idle start wind speed: Cut in wind speed from power curve

Table with columns for months (January-December) and rows for days (1-31) and summary rows. Each cell contains sun rise and set times. Summary rows include Potential sun hours, Total, worst case, Sun reduction, Oper. time red., Wind dir. red., Total reduction, and Total, real.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

Project: Description:
Otis Real Case Shadow Flicker Assessment for Town of Otis - Algeria Rd. Site
GE 1.7 103m Rotor 80m Hub
Real Case Statistics:
Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)
APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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SHADOW - Calendar

Calculation: Otis Shadow Flicker - Algeria Rd. REAL CASE Shadow receptor: H - SR11

Assumptions for shadow calculations

Maximum distance for influence 2,000 m
Minimum sun height over horizon for influence 3 °
Day step for calculation 1 days
Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21
Operational time
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum
442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367
Idle start wind speed: Cut in wind speed from power curve

Table with columns for months (January to December) and rows for each day (1-31) showing sun rise and set times. Includes summary rows for potential sun hours, total reduction, and total real hours.

Table layout: For each day in each month the following matrix apply

Day in month Sun rise (hh:mm) Sun set (hh:mm) Minutes with flicker First time (hh:mm) with flicker Last time (hh:mm) with flicker (WTG causing flicker first time) (WTG causing flicker last time)

Project: Otis
Description: Real Case Shadow Flicker Assessment for Town of Otis - Algeria Rd. Site
GE 1.7 103m Rotor 80m Hub
Real Case Statistics:
Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)
APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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SHADOW - Calendar

Calculation: Otis Shadow Flicker - Algeria Rd. REAL CASE Shadow receptor: I - SR14

Assumptions for shadow calculations

Maximum distance for influence: 2,000 m
Minimum sun height over horizon for influence: 3 °
Day step for calculation: 1 days
Time step for calculation: 1 minutes

Sunshine probability S (Average daily sunshine hours) []
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21

Operational time
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum
442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367
Idle start wind speed: Cut in wind speed from power curve

Table with 12 columns for months (January to December) and rows for each day of the month. Columns contain sun rise and set times, and a final row summarizes 'Potential sun hours' and 'Total, real' values.

Table layout: For each day in each month the following matrix apply

Matrix with 4 columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project: Otis
Description: Real Case Shadow Flicker Assessment for Town of Otis - Algerie Rd. Site
GE 1.7 103m Rotor 80m Hub
Real Case Statistics:
Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)
APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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SHADOW - Calendar

Calculation: Otis Shadow Flicker - Algerie Rd. REAL CASE Shadow receptor: J - SR15

Assumptions for shadow calculations

Maximum distance for influence 2,000 m
Minimum sun height over horizon for influence 3 °
Day step for calculation 1 days
Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21

Operational time
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum
442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367
Idle start wind speed: Cut in wind speed from power curve

Table with columns for months (January to December) and rows for each day (1-31) showing sunrise/sunset times and potential sun hours. Includes summary rows for 'Total, worst case', 'Sun reduction', 'Oper. time red.', 'Wind dir. red.', 'Total reduction', and 'Total, real'.

Table layout: For each day in each month the following matrix apply

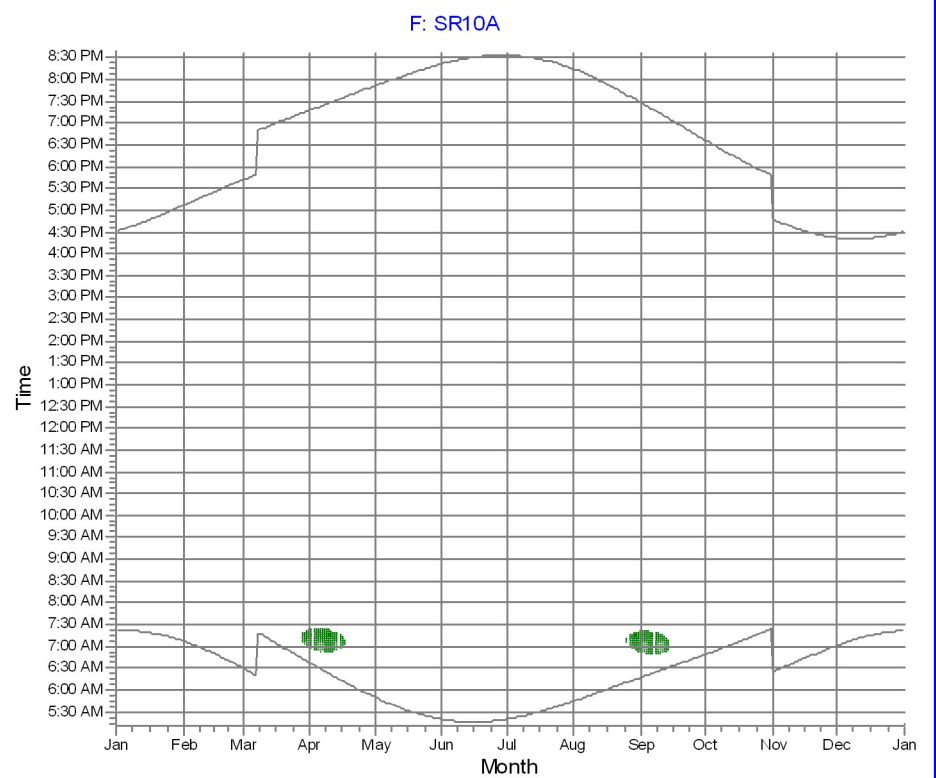
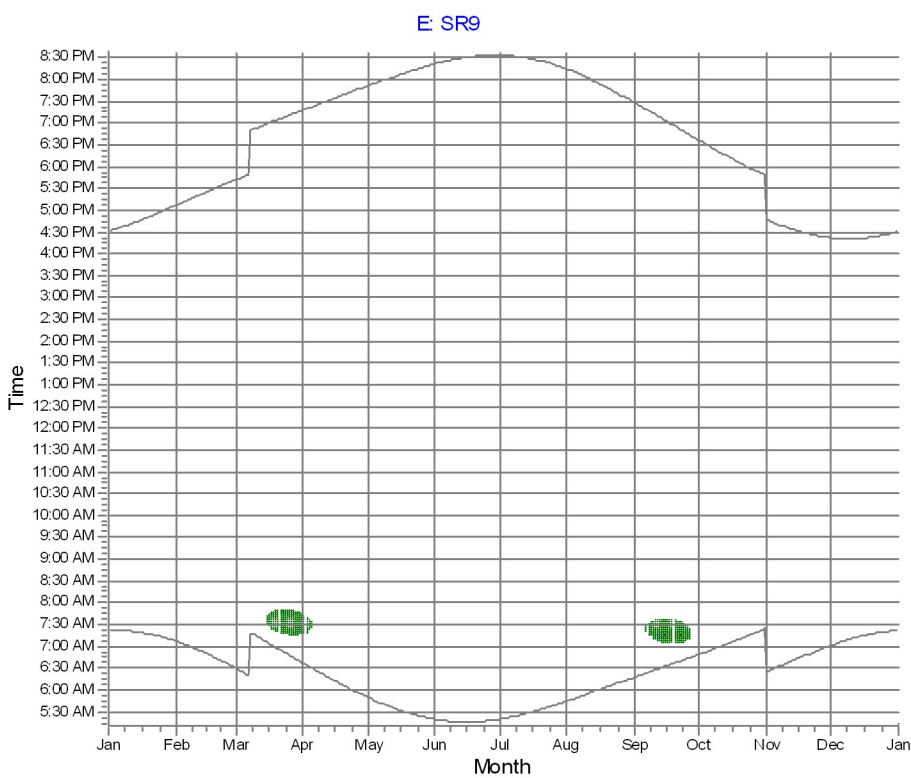
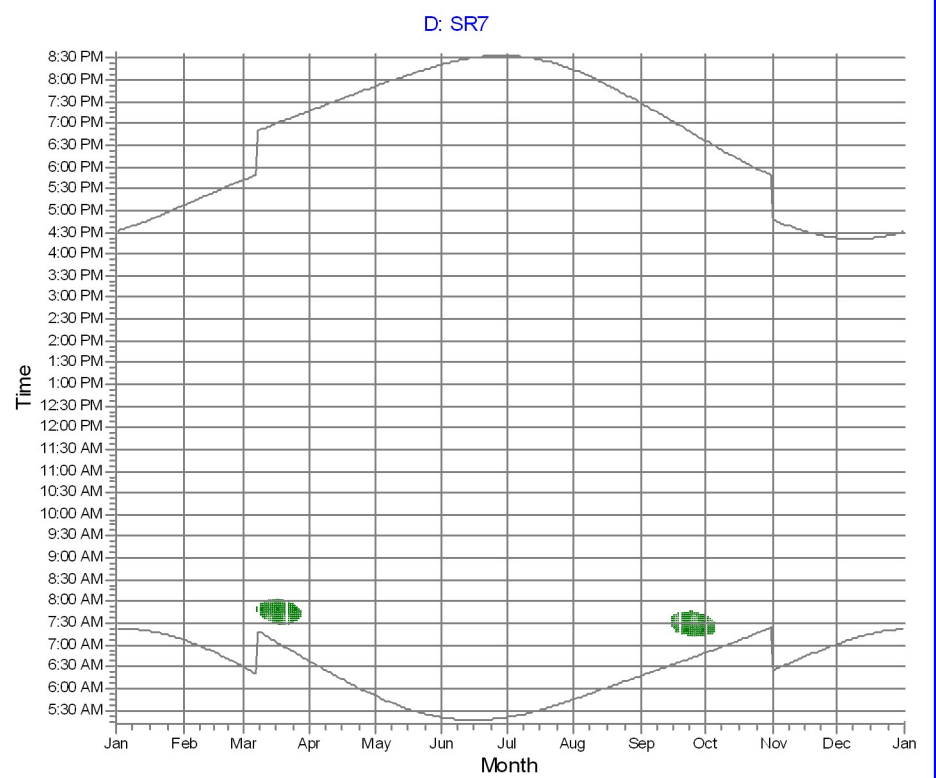
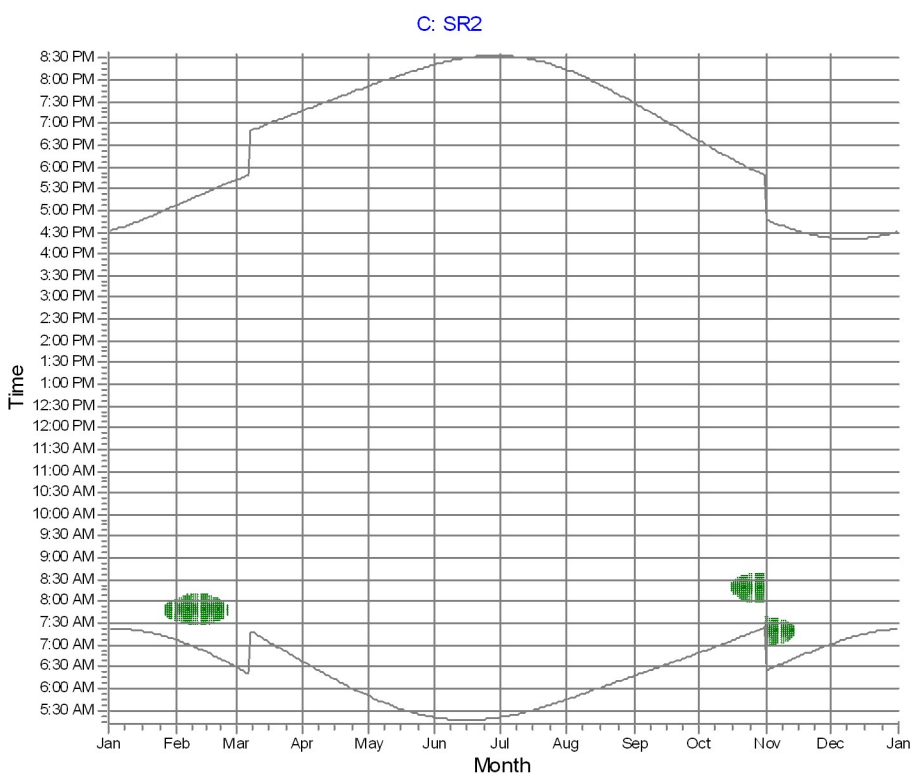
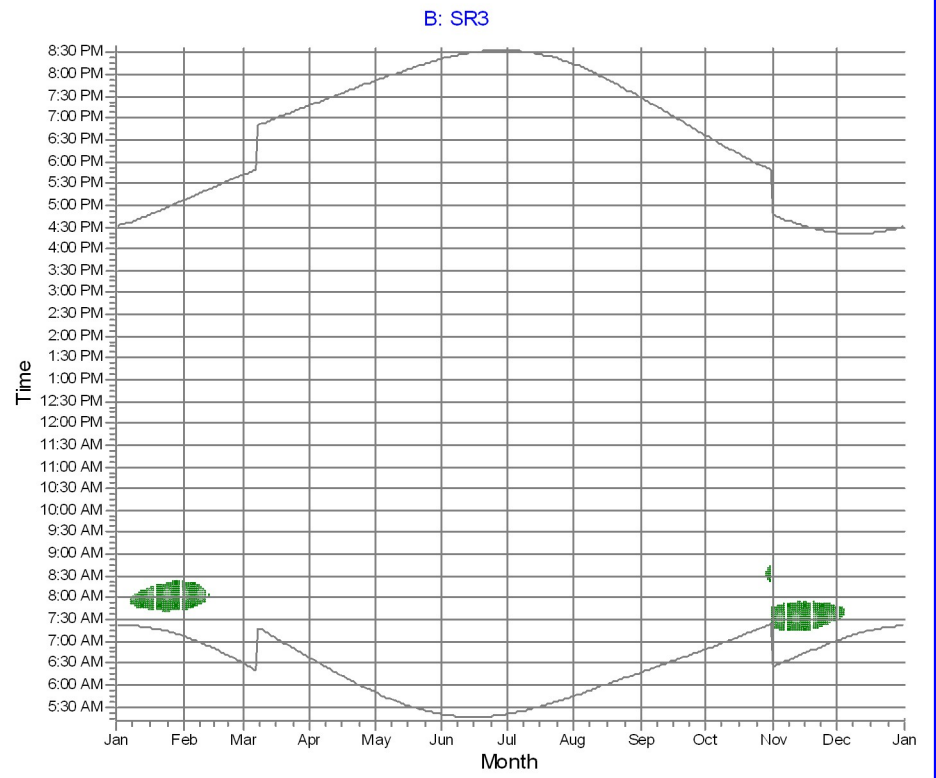
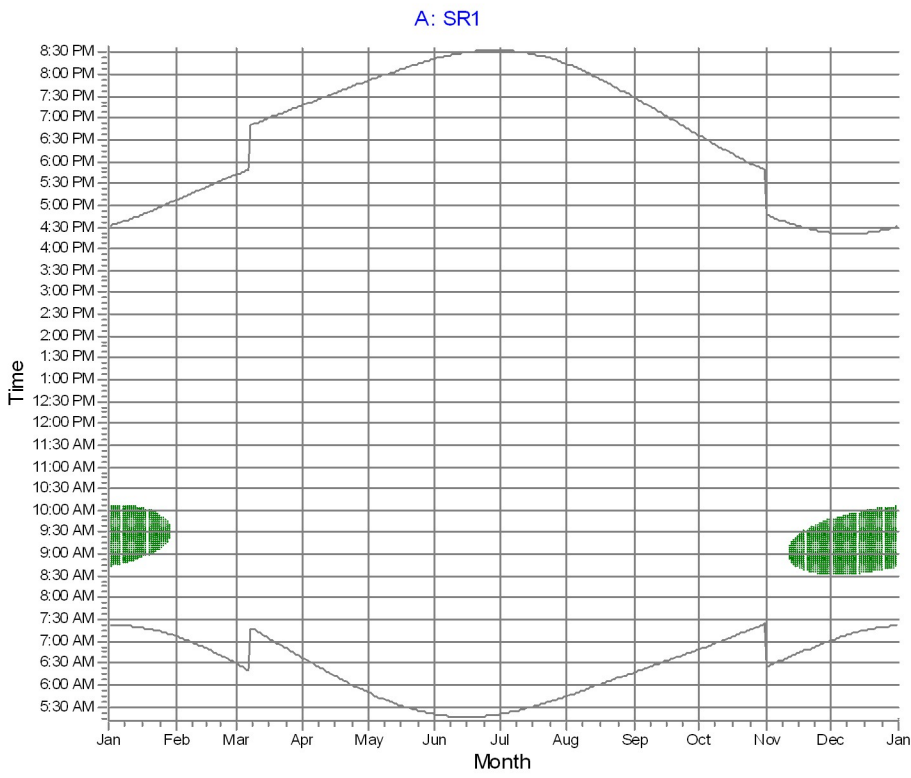
Matrix with 4 columns: Day in month, Sun rise (hh:mm), Sun set (hh:mm), Minutes with flicker, First time (hh:mm) with flicker, Last time (hh:mm) with flicker, (WTG causing flicker first time), (WTG causing flicker last time)

Project: **Otis**  
 Description: Real Case Shadow Flicker Assessment for Town of Otis - Algerie Rd. Site  
 GE 1.7 103m Rotor 80m Hub  
 Real Case Statistics:  
 Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)  
 APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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**SHADOW - Calendar, graphical**

Calculation: Otis Shadow Flicker - Algerie Rd. REAL CASE



WTGs

1: GE 1.7 103m Rotor 80m Hub

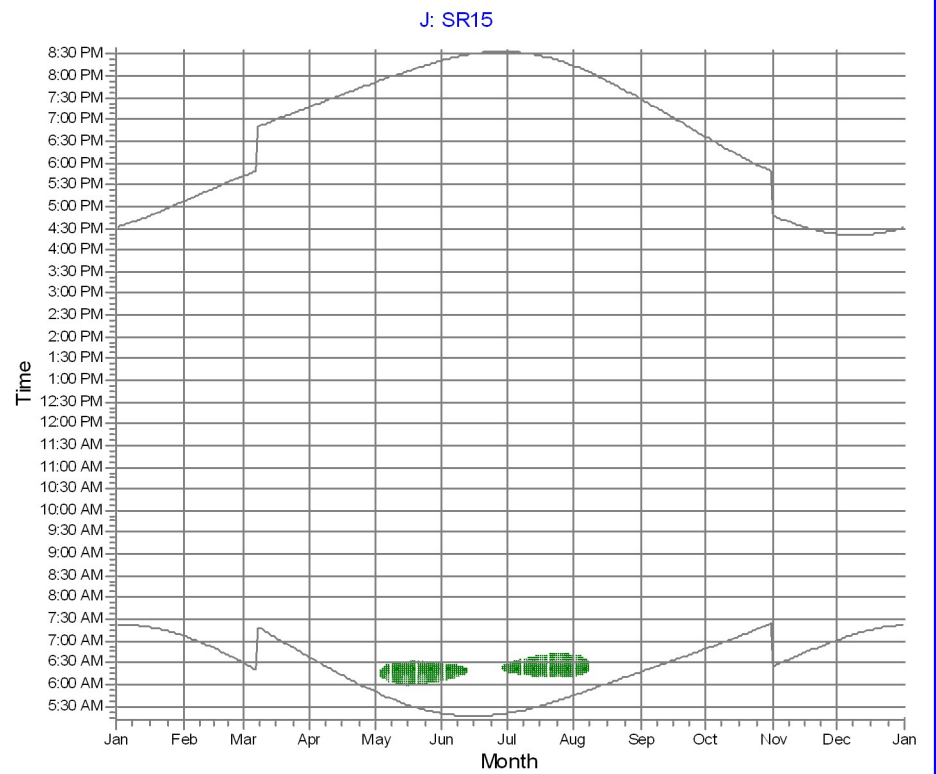
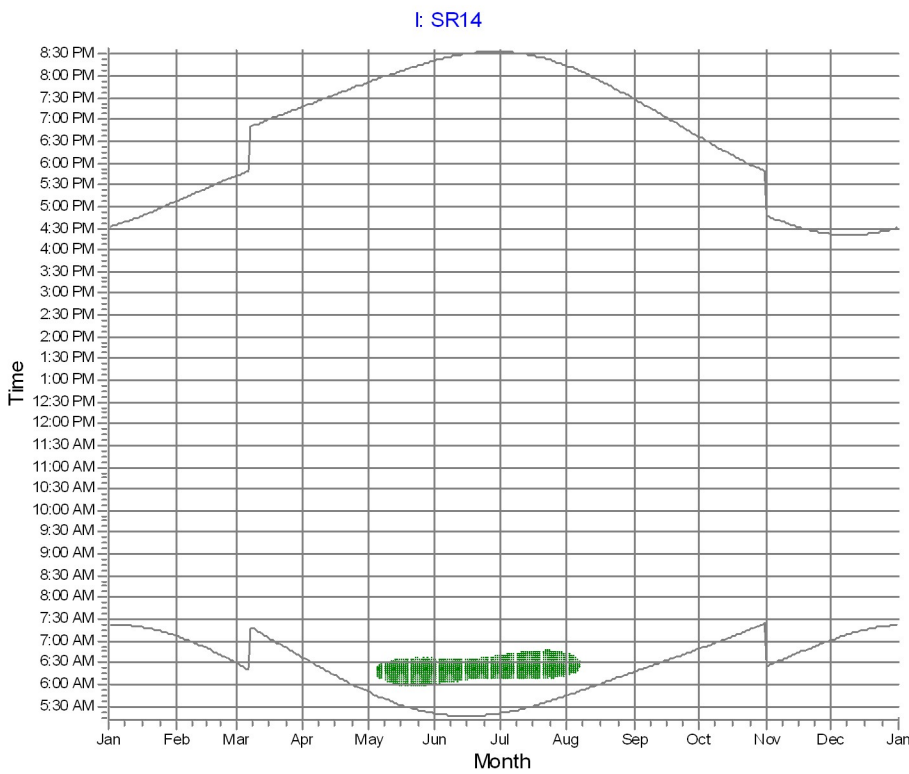
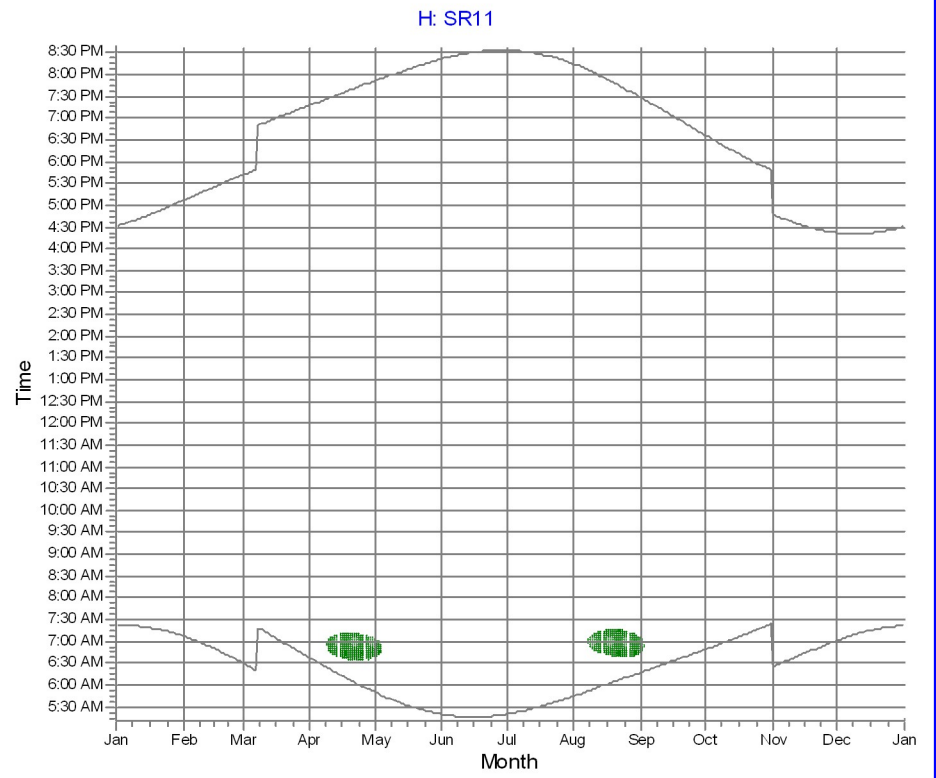
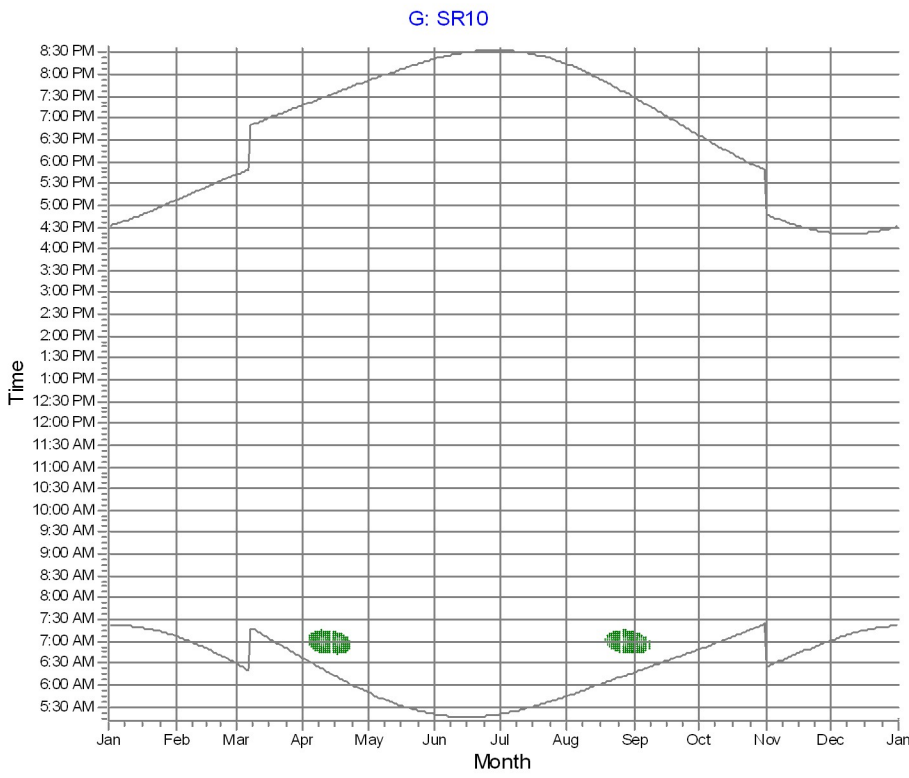


Project: **Otis**  
 Description: Real Case Shadow Flicker Assessment for Town of Otis - Algeria Rd. Site  
 GE 1.7 103m Rotor 80m Hub  
 Real Case Statistics:  
 Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)  
 APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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**SHADOW - Calendar, graphical**

Calculation: Otis Shadow Flicker - Algeria Rd. REAL CASE



WTGs

1: GE 1.7 103m Rotor 80m Hub

Project: **Otis**  
 Description: Real Case Shadow Flicker Assessment for Town of Otis - Algeria Rd. Site  
 GE 1.7 103m Rotor 80m Hub  
 Real Case Statistics:  
 Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)  
 APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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**SHADOW - Calendar per WTG**

Calculation: Otis Shadow Flicker - Algeria Rd. REAL CASE WTG: 1 - GE 1.7 103m Rotor 80m Hub

**Assumptions for shadow calculations**

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []  
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21

Operational time  
 N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:22 08:42-10:04/82 16:31	07:07 07:33-08:02/29 17:06 08:02-08:20/18	06:29 17:42	06:37 06:58-07:22/24 19:18 07:22-07:42/20	05:49 06:37-07:01/24 19:51	05:19 05:59-06:28/29 20:21 06:28-06:34/6
2	07:22 08:42-10:04/82 16:32	07:06 07:31-08:02/31 17:07 08:02-08:19/17	06:28 17:43	06:35 06:56-07:23/27 19:19 07:23-07:40/17	05:48 06:39-06:59/20 19:52	05:19 06:00-06:28/28 20:22 06:28-06:34/6
3	07:22 08:43-10:04/81 16:32	07:05 07:31-08:04/33 17:09 08:04-08:19/15	06:26 17:44	06:33 06:54-07:23/29 19:20 07:23-07:38/15	05:46 06:41-06:58/17 19:53	05:18 06:00-06:27/27 20:23 06:27-06:34/7
4	07:22 08:44-10:04/80 16:33	07:04 07:30-08:05/35 17:10 08:05-08:19/14	06:24 17:45	06:31 06:54-07:07/13 19:21 07:07-07:36/29	05:45 06:11-06:18/7 19:54 06:43-06:54/11	05:18 06:01-06:26/25 20:23 06:26-06:34/8
5	07:22 08:44-10:04/80 16:34	07:02 07:30-08:06/36 17:11 08:06-08:18/12	06:23 17:47	06:30 06:51-07:09/18 19:22 07:09-07:23/14	07:24-07:32/8 19:56	05:17 06:01-06:26/25 20:24 06:26-06:34/8
6	07:22 08:45-10:04/79 16:35	07:01 07:29-08:07/38 17:13 08:07-08:18/11	06:21 17:48	06:28 06:48-07:10/22 19:23 07:10-07:22/12	05:43 06:06-06:23/17 19:57	05:17 06:02-06:26/24 20:25 06:26-06:34/8
7	07:22 08:45-10:04/79 16:36	07:00 07:29-08:08/39 17:14 08:08-08:18/10	06:19 17:49	06:26 06:47-07:12/25 19:24 07:12-07:23/11	05:41 06:04-06:25/21 19:58	05:17 06:02-06:25/23 20:26 06:25-06:34/9
8	07:21 07:50-07:58/8 16:37 08:46-10:04/78	06:59 07:28-08:07/39 17:15 08:07-08:16/9	07:18 07:44-07:49/5 18:50	06:25 06:46-07:12/26 19:25 07:12-07:22/10	05:40 06:03-06:27/24 19:59	05:17 06:02-06:25/23 20:26 06:25-06:34/9
9	07:21 07:49-08:01/12 16:38 08:48-10:04/76	06:58 07:28-08:08/40 17:17 08:08-08:15/7	07:16 07:40-07:55/15 18:51	06:23 06:44-06:57/13 19:27 06:56-07:21/25	05:39 06:02-06:27/25 20:00	05:16 06:03-06:24/21 20:27 06:24-06:34/10
10	07:21 07:47-08:02/15 16:39 08:48-10:04/76	06:57 07:28-08:08/40 17:18 08:08-08:14/6	07:14 07:37-07:56/19 18:53	06:21 06:44-07:04/20 19:28 07:03-07:21/18	05:38 06:01-06:28/27 20:00	05:16 06:03-06:24/21 20:27 06:24-06:34/10
11	07:21 07:46-08:04/18 16:40 08:49-10:04/75	06:55 07:28-08:09/41 17:19 08:09-08:12/3	07:13 07:35-07:58/23 18:54	06:20 06:43-07:06/23 19:29 07:05-07:20/15	05:37 06:00-06:29/29 20:01	05:16 06:04-06:23/19 20:28 06:23-06:34/11
12	07:20 07:46-08:06/20 16:42 08:50-10:04/74	06:54 07:27-08:08/41 17:20 08:08-08:09/1	07:11 07:34-07:59/25 18:55	06:18 06:41-07:07/26 19:30 07:06-07:18/12	05:36 06:00-06:29/29 20:02 06:29-06:30/1	05:16 06:03-06:21/18 20:29 06:21-06:33/12
13	07:20 07:45-08:07/22 16:43 08:50-10:03/73	06:53 07:28-08:08/40 17:22	07:09 07:32-08:00/28 18:56	06:16 06:40-07:09/29 19:31 07:08-07:18/10	05:34 05:59-06:30/31 20:03 06:30-06:31/1	05:16 06:04-06:20/16 20:29 06:20-06:33/13
14	07:20 07:45-08:09/24 16:44 08:52-10:03/71	06:51 07:28-08:08/40 17:23	07:08 07:31-08:00/29 18:57	06:15 06:38-07:09/31 19:32 07:08-07:16/8	05:33 05:59-06:30/31 20:04 06:30-06:32/2	05:16 06:04-06:33/29 20:30
15	07:19 07:44-08:09/25 16:45 08:52-10:02/70	06:50 07:28-08:07/39 17:24	07:06 07:30-08:00/30 18:58	06:13 06:38-07:11/33 19:33 07:10-07:14/4	05:32 05:59-06:30/31 20:05 06:30-06:32/2	05:16 06:05-06:33/28 20:30
16	07:19 07:44-08:11/27 16:46 08:54-10:02/68	06:49 07:29-08:07/38 17:26	07:04 07:30-07:41/11 19:00 07:41-08:01/20	06:12 06:36-07:11/35 19:34 07:10-07:11/1	05:31 05:58-06:30/32 20:06 06:30-06:33/3	05:16 06:05-06:33/28 20:30
17	07:18 07:43-08:12/29 16:47 08:54-10:01/67	06:47 07:28-08:06/38 17:27	07:02 07:26-07:44/18 19:01 07:44-08:01/17	06:10 06:35-07:09/34 19:36	05:30 05:58-06:30/32 20:07 06:30-06:33/3	05:16 06:06-06:34/28 20:31
18	07:18 07:43-08:13/30 16:49 08:56-10:01/65	06:46 07:29-08:06/37 17:28	07:01 07:23-07:45/22 19:02 07:45-08:00/15	06:08 06:35-07:09/34 19:37	05:29 05:59-06:31/32 20:08 06:31-06:34/3	05:16 06:06-06:34/28 20:31
19	07:17 07:42-08:14/32 16:50 08:57-10:00/63	06:44 07:30-08:04/34 17:29	06:59 07:21-07:46/25 19:03 07:46-08:00/14	06:07 06:34-07:09/35 19:38	05:28 05:58-06:31/33 20:09 06:31-06:34/3	05:16 06:07-06:34/27 20:32
20	07:17 07:42-08:15/33 16:51 08:58-09:59/61	06:43 07:31-08:04/33 17:31	06:57 07:20-07:48/28 19:04 07:48-08:00/12	06:05 06:34-07:09/35 19:39	05:28 05:58-06:31/33 20:10 06:31-06:34/3	05:16 06:07-06:34/27 20:32
21	07:16 07:42-08:16/34 16:52 08:59-09:58/59	06:41 07:31-08:02/31 17:32	06:56 07:19-07:48/29 19:05 07:48-07:59/11	06:04 06:33-07:09/36 19:40	05:27 05:58-06:31/33 20:11 06:31-06:34/3	05:16 06:07-06:34/27 20:32
22	07:15 07:42-08:17/35 16:53 09:01-09:57/56	06:40 07:33-08:01/28 17:33	06:54 07:20-07:49/32 19:06 07:49-07:58/9	06:02 06:34-07:09/35 19:41	05:26 05:57-06:30/33 20:12 06:30-06:34/4	05:16 06:07-06:34/27 20:32
23	07:15 07:41-08:17/36 16:55 09:02-09:56/54	06:38 07:34-07:59/25 17:34	06:52 07:16-07:49/33 19:07 07:49-07:56/7	06:01 06:33-07:08/35 19:42	05:25 05:58-06:31/33 20:13 06:31-06:35/4	05:17 06:08-06:35/27 20:33
24	07:14 07:41-08:17/36 16:56 09:04-09:54/50	06:37 07:36-07:57/21 17:36	06:50 07:16-07:49/33 19:09 07:49-07:55/6	05:59 06:33-07:08/35 19:43	05:24 05:58-06:30/32 20:14 06:30-06:35/5	05:17 06:07-06:35/28 20:33
25	07:13 07:41-08:18/37 16:57 09:05-09:52/47	06:35 07:39-07:54/15 17:37	06:49 07:16-07:49/33 19:10 07:49-07:54/5	05:58 06:33-07:07/34 19:44	05:23 05:58-06:30/32 20:15 06:30-06:34/4	05:17 06:07-06:35/28 20:33
26	07:12 07:41-08:18/37 16:58 09:07-09:50/43	06:34 17:38	06:47 07:15-07:48/33 19:11 07:48-07:51/3	05:56 06:34-07:06/32 19:46	05:23 05:57-06:30/33 20:16 06:30-06:34/4	05:17 06:08-06:36/28 20:33
27	07:11 07:42-08:19/37 17:00 09:11-09:49/38	06:32 17:39	06:45 07:14-07:48/34 19:12	05:55 06:35-07:06/31 19:47	05:22 05:58-06:30/32 20:17 06:30-06:35/5	05:18 06:08-06:36/28 20:33
28	07:11 07:40-07:53/13 09:13-09:46/33 17:01 07:53-08:20/27	06:31 17:41	06:43 07:15-07:47/32 19:13	05:53 06:34-07:04/30 19:48	05:21 05:58-06:29/31 20:18 06:29-06:34/5	05:18 06:07-06:36/29 20:33
29	07:10 07:38-07:56/18 09:16-09:43/27 17:02 07:56-08:20/24		06:42 07:04-07:17/13 19:14 07:17-07:46/29	05:52 06:36-07:04/28 19:49	05:21 05:59-06:29/30 20:19 06:29-06:35/6	05:19 06:08-06:24/16 20:33 06:24-06:37/13
30	07:09 07:36-07:59/23 09:21-09:38/17 17:04 07:59-08:20/21		06:40 07:01-07:19/18 19:15 07:19-07:45/26	05:51 06:37-07:03/26 19:50	05:20 05:59-06:28/29 20:19 06:28-06:34/6	05:19 06:08-06:25/17 20:33 06:25-06:37/12
31	07:08 07:34-08:00/26 17:05 08:00-08:20/20		06:38 06:59-07:21/22 19:16 07:21-07:44/23		05:20 05:59-06:28/29 20:20 06:28-06:35/7	
Potential sun hours	294	296	370	401	451	456
Sum of minutes with flicker	2623	984	787	1075	940	891

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project: **Otis** Description: Real Case Shadow Flicker Assessment for Town of Otis - Algeria Rd. Site  
 GE 1.7 103m Rotor 80m Hub  
 Real Case Statistics:  
 Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)  
 APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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 317 State Route 104  
 US-14519 Ontario, NY  
 4738  
 Scott Abbett / scott.abbett@sed-net.com  
 Calculated: 9/3/2015 1:59 PM/2.7.486

**SHADOW - Calendar per WTG**

Calculation: Otis Shadow Flicker - Algeria Rd. REAL CASE WTG: 1 - GE 1.7 103m Rotor 80m Hub

**Assumptions for shadow calculations**

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []  
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 4.36 5.29 6.92 7.87 7.57 8.36 8.51 8.05 7.00 6.10 4.62 4.21

Operational time  
 N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 442 226 352 623 302 199 233 473 992 1,070 1,285 2,170 8,367  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:20 06:08-06:27/19 20:33 06:27-06:38/11	05:45 06:10-06:40/30 20:14 06:40-06:41/1	06:17 06:42-07:05/23 19:28 07:04-07:19/15	06:49 07:12-07:39/27 18:35	06:25 06:58-07:38/40 16:47 07:38-07:44/6	07:01 07:28-07:46/18 16:22 08:31-09:46/75
2	05:20 06:08-06:27/19 20:33 06:27-06:38/11	05:46 06:11-06:39/28 20:13 06:39-06:40/1	06:18 06:42-07:02/20 19:26 07:01-07:19/18	06:50 07:13-07:37/24 18:34	06:26 06:58-07:38/40 16:46 07:38-07:45/7	07:02 07:30-07:45/15 16:21 08:31-09:47/76
3	05:21 06:08-06:29/21 20:33 06:29-06:39/10	05:47 06:12-06:38/26 20:11 06:38-06:39/1	06:19 06:42-06:55/13 19:24 06:54-07:19/25	06:51 07:14-07:35/21 18:32	06:27 06:58-07:37/39 16:45 07:37-07:46/9	07:03 07:32-07:44/12 16:21 08:31-09:47/76
4	05:21 06:07-06:29/22 20:33 06:29-06:39/10	05:48 06:12-06:37/25 20:10	06:20 06:43-07:09/26 19:23 07:09-07:19/10	06:52 07:15-07:32/17 18:30	06:29 06:59-07:37/38 16:43 07:37-07:47/10	07:04 07:34-07:42/8 16:21 08:31-09:48/77
5	05:22 06:08-06:31/23 20:32 06:31-06:40/9	05:49 06:13-06:36/23 20:09	06:21 06:43-07:08/25 19:21 07:08-07:19/11	06:53 07:18-07:29/11 18:29	06:30 06:59-07:36/37 16:42 07:36-07:48/12	07:05 08:31-09:49/78 16:21
6	05:22 06:08-06:32/24 20:32 06:32-06:40/8	05:50 06:15-06:34/19 20:08	06:22 06:44-07:06/22 19:19 07:06-07:18/12	06:54 18:27	06:31 06:59-07:35/36 16:41 07:35-07:48/13	07:06 08:31-09:50/79 16:21
7	05:23 06:08-06:32/24 20:32 06:32-06:40/8	05:51 06:16-06:32/16 20:07	06:23 06:46-07:04/18 19:18 07:04-07:18/14	06:55 18:25	06:32 07:01-07:35/34 16:40 07:35-07:50/15	07:07 08:31-09:51/80 16:20
8	05:24 06:08-06:33/25 20:32 06:33-06:41/8	05:52 06:18-06:30/12 20:05 06:56-07:00/4	06:24 06:48-07:01/13 19:16 07:01-07:30/29	06:57 18:24	06:33 07:02-07:34/32 16:39 07:34-07:50/16	07:08 08:31-09:51/80 16:20
9	05:24 06:07-06:33/26 20:31 06:33-06:41/8	05:53 06:51-07:05/14 20:04	06:25 06:48-07:17/29 19:14 07:17-07:32/15	06:58 18:22	06:35 07:02-07:33/31 16:38 07:33-07:50/17	07:09 08:31-09:52/81 16:20
10	05:25 06:07-06:35/28 20:31 06:35-06:41/6	05:54 06:49-07:07/18 20:03	06:27 06:49-07:16/27 19:12 07:16-07:33/17	06:59 18:20	06:36 07:04-07:33/29 16:37 07:33-07:51/18	07:10 08:32-09:53/81 16:20
11	05:26 06:08-06:36/28 20:30 06:36-06:42/6	05:55 06:47-07:08/21 20:01	06:28 06:50-07:15/25 19:11 07:15-07:34/19	07:00 18:19	06:37 07:05-07:31/26 16:36 07:31-07:51/20	07:11 08:32-09:54/82 16:20
12	05:27 06:08-06:36/28 20:30 06:36-06:43/7	05:56 06:46-07:10/24 20:00	06:29 06:50-07:13/23 19:09 07:13-07:35/22	07:01 18:17	06:38 07:07-07:29/22 16:35 07:29-07:51/22	07:12 08:32-09:55/83 16:21
13	05:27 06:07-06:36/29 20:29 06:36-06:42/6	05:57 06:44-07:11/27 19:57	06:30 06:52-07:11/19 19:07 07:11-07:36/25	07:02 18:15	06:40 07:10-07:28/18 16:34 07:28-07:52/24	07:12 08:32-09:54/82 16:21
14	05:28 06:07-06:37/30 20:29 06:37-06:43/6	05:58 06:43-07:12/29 19:56	06:31 06:54-07:08/14 19:05 07:08-07:36/28	07:03 18:14	06:41 07:12-07:25/13 16:33 07:25-07:52/27	07:13 08:32-09:55/83 16:21
15	05:29 06:07-06:38/31 20:28 06:38-06:43/5	05:59 06:42-07:12/30 19:54	06:32 07:04-07:36/32 19:04	07:04 18:12	06:42 07:14-07:51/37 16:32 08:42-09:21/39	07:14 08:33-09:56/83 16:21
16	05:30 06:08-06:39/31 20:28 06:39-06:44/5	06:00 06:41-07:13/32 19:53	06:33 07:04-07:37/33 19:02	07:06 08:14-08:23/9 18:10	06:43 07:15-07:52/37 16:31 08:41-09:24/43	07:15 08:34-09:57/83 16:21
17	05:31 06:07-06:38/31 20:27 06:38-06:43/5	06:01 06:40-07:13/33 19:52	06:34 07:03-07:37/34 19:00 07:37-07:39/2	07:07 08:09-08:26/17 18:09	06:45 07:15-07:52/37 16:30 08:39-09:26/47	07:15 08:33-09:57/84 16:22
18	05:31 06:07-06:39/32 20:26 06:39-06:44/5	06:02 06:40-07:13/33 19:50	06:35 07:03-07:36/33 18:58 07:36-07:41/5	07:08 08:07-08:29/22 18:07	06:46 07:15-07:51/36 16:29 08:38-09:28/50	07:16 08:34-09:58/84 16:22
19	05:32 06:07-06:40/33 20:26 06:40-06:44/4	06:03 06:39-07:14/35 19:49	06:36 07:03-07:36/33 18:57 07:36-07:42/6	07:09 08:05-08:31/26 18:06	06:47 07:15-07:51/36 16:28 08:36-09:30/54	07:17 08:35-09:59/84 16:22
20	05:33 06:08-06:40/32 20:25 06:40-06:44/4	06:04 06:39-07:14/35 19:47	06:37 07:03-07:35/32 18:55 07:35-07:42/7	07:10 08:03-08:32/29 18:04	06:48 07:17-07:52/35 16:28 08:36-09:32/56	07:17 08:35-09:59/84 16:23
21	05:34 06:08-06:41/33 20:24 06:41-06:44/3	06:05 06:38-07:14/36 19:46	06:38 07:03-07:34/31 18:53 07:34-07:43/9	07:11 08:01-08:33/32 18:03	06:50 07:17-07:51/34 16:27 08:35-09:34/59	07:18 08:36-10:00/84 16:23
22	05:35 06:08-06:41/33 20:23 06:41-06:45/4	06:07 06:38-07:13/35 19:44	06:39 07:03-07:33/30 18:51 07:33-07:43/10	07:13 08:01-08:35/34 18:01	06:51 07:18-07:51/33 16:26 08:34-09:35/61	07:18 08:36-10:00/84 16:24
23	05:36 06:08-06:41/33 20:23 06:41-06:45/4	06:08 06:38-07:13/35 19:42	06:40 07:03-07:32/29 18:49 07:32-07:43/11	07:14 08:00-08:35/35 18:00	06:52 07:19-07:51/32 16:26 08:34-09:37/63	07:19 08:37-10:01/84 16:24
24	05:37 06:09-06:42/33 20:22 06:42-06:45/3	06:09 06:38-07:13/35 19:41	06:41 07:05-07:31/26 18:48 07:31-07:44/13	07:15 07:59-08:35/36 17:58	06:53 07:20-07:50/30 16:25 08:33-09:38/65	07:19 08:37-10:01/84 16:25
25	05:38 06:08-06:41/33 20:21 06:41-06:44/3	06:10 06:38-07:12/34 19:39	06:42 07:06-07:29/23 18:46 07:29-07:44/15	07:16 07:58-08:36/38 17:57	06:54 07:21-07:50/29 16:24 08:32-09:39/67	07:20 08:37-10:01/84 16:25
26	05:39 06:08-06:41/33 20:20 06:41-06:43/2	06:11 06:38-07:12/34 19:38	06:43 07:08-07:27/19 18:44 07:27-07:43/16	07:17 07:58-08:37/39 17:55	06:55 07:22-07:49/27 16:24 08:32-09:40/68	07:20 08:38-10:02/84 16:26
27	05:40 06:09-06:41/32 20:19 06:41-06:43/2	06:12 06:38-07:12/34 19:36 07:11-07:14/3	06:44 07:10-07:24/14 18:42 07:24-07:43/19	07:19 07:57-08:37/40 17:54	06:57 07:23-07:49/26 16:23 08:31-09:41/70	07:20 08:38-10:02/84 16:27
28	05:41 06:09-06:41/32 20:18 06:41-06:43/2	06:13 06:39-07:11/32 19:34 07:10-07:15/5	06:46 07:11-07:42/31 18:41	07:20 07:57-08:37/40 17:53	06:58 07:25-07:49/24 16:23 08:32-09:43/71	07:21 08:39-10:02/83 16:27
29	05:42 06:09-06:41/32 20:17 06:41-06:43/2	06:14 06:39-07:10/31 19:33 07:09-07:17/8	06:47 07:11-07:41/30 18:39	07:21 07:57-08:37/40 17:51	06:59 07:26-07:48/22 16:22 08:31-09:44/73	07:21 08:39-10:02/83 16:28
30	05:43 06:10-06:41/31 20:16 06:41-06:42/1	06:15 06:40-07:09/29 19:31 07:08-07:18/10	06:48 07:11-07:40/29 18:37	07:22 07:57-08:38/41 17:50 08:38-08:39/1	07:00 07:27-07:47/20 16:22 08:31-09:45/74	07:21 08:40-10:02/82 16:29
31	05:44 06:10-06:40/30 20:15 06:40-06:41/1	06:16 06:41-07:07/26 19:29 07:06-07:18/12		07:24 07:57-08:38/41 17:48 08:38-08:41/3		07:21 08:41-10:04/83 16:30
Potential sun hours	463	430	375	344	295	284
Sum of minutes with flicker	1060	911	1135	623	2184	2587

Table layout: For each day in each month the following matrix apply

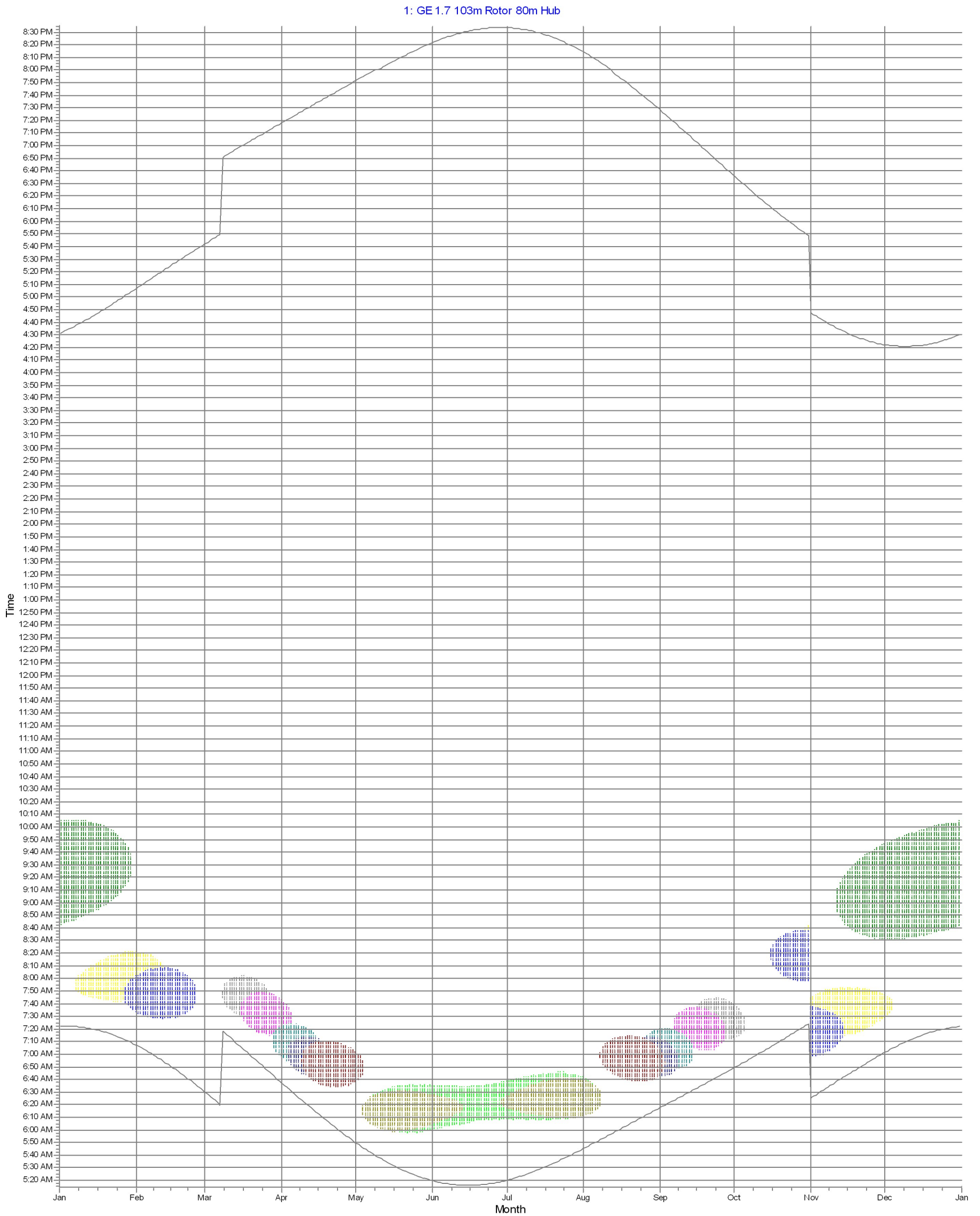
Day in month Sun rise (hh:mm) First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker  
 Sun set (hh:mm) First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project: **Otis**  
 Description: Real Case Shadow Flicker Assessment for Town of Otis - Algerie Rd. Site  
 GE 1.7 103m Rotor 80m Hub  
 Real Case Statistics:  
 Average Percent of Possible Sunshine (APPS) Obtained from NOAA - National Climatic Data Center (www.ncdc.noaa.gov)  
 APPS Gathered at Blue Hill Observatory in Milton, MA (Data Span 1896-2009)

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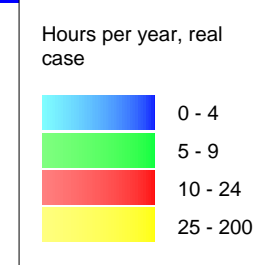
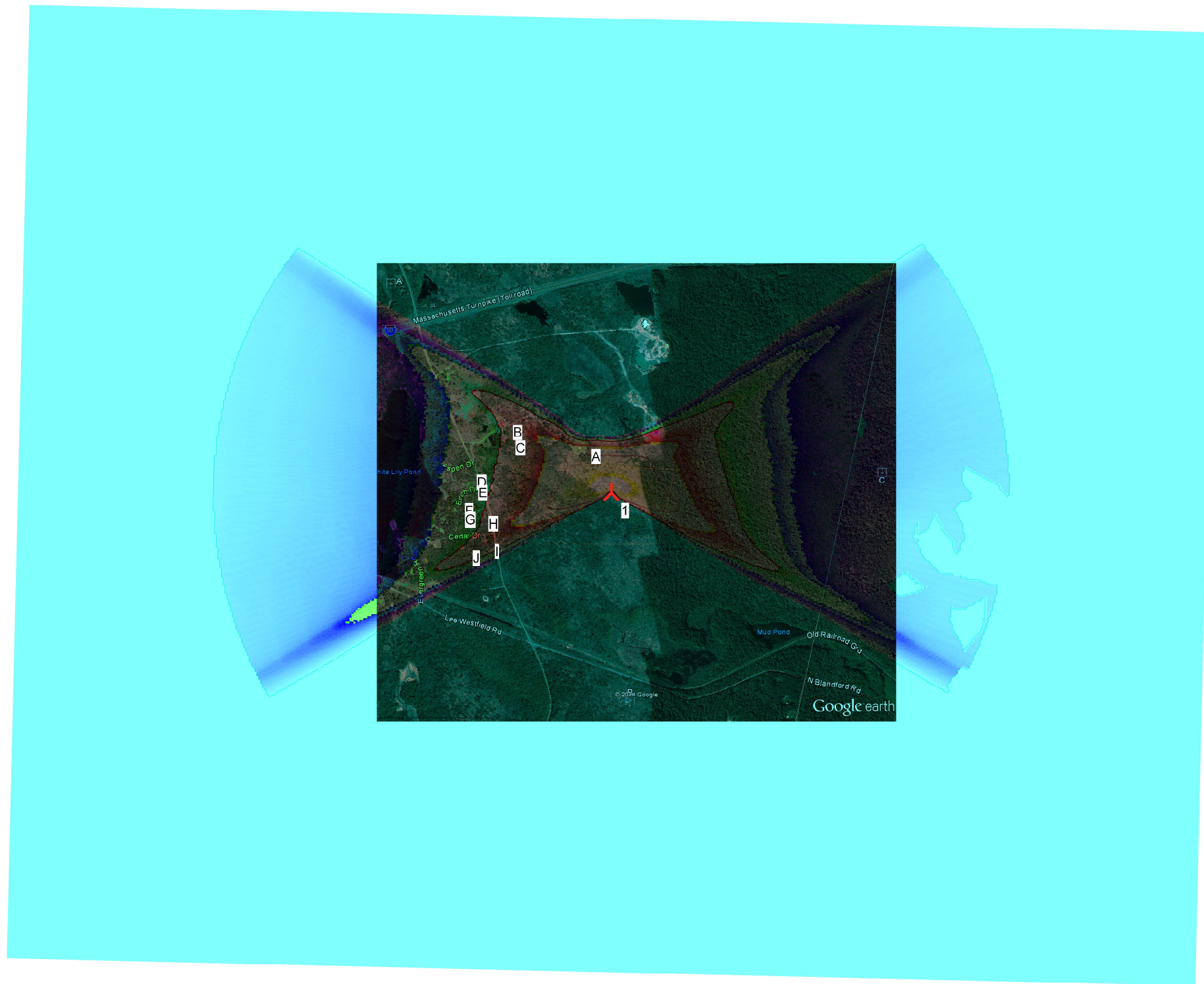
**SHADOW - Calendar per WTG, graphical**

Calculation: Otis Shadow Flicker - Algerie Rd. REAL CASE WTG: 1 - GE 1.7 103m Rotor 80m Hub



Shadow receptor

- |                                                                                                                                   |                                                                                                                                 |                                                                                                                                    |                                                                                                                                      |                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| <span style="display: inline-block; width: 15px; height: 15px; background-color: green; border: 1px solid black;"></span> A: SR1  | <span style="display: inline-block; width: 15px; height: 15px; background-color: blue; border: 1px solid black;"></span> C: SR2 | <span style="display: inline-block; width: 15px; height: 15px; background-color: magenta; border: 1px solid black;"></span> E: SR9 | <span style="display: inline-block; width: 15px; height: 15px; background-color: darkblue; border: 1px solid black;"></span> G: SR10 | <span style="display: inline-block; width: 15px; height: 15px; background-color: lightgreen; border: 1px solid black;"></span> I: SR14 |
| <span style="display: inline-block; width: 15px; height: 15px; background-color: yellow; border: 1px solid black;"></span> B: SR3 | <span style="display: inline-block; width: 15px; height: 15px; background-color: grey; border: 1px solid black;"></span> D: SR7 | <span style="display: inline-block; width: 15px; height: 15px; background-color: teal; border: 1px solid black;"></span> F: SR10A  | <span style="display: inline-block; width: 15px; height: 15px; background-color: red; border: 1px solid black;"></span> H: SR11      | <span style="display: inline-block; width: 15px; height: 15px; background-color: olive; border: 1px solid black;"></span> J: SR15      |



**Project:**  
**Otis**

**Description:**  
 Real Case Shadow Flicker Assessment for  
 Town of Otis - Algeria Rd. Site  
 GE 1.7 103m Rotor 80m Hub  
**Real Case Statistics:**  
 Average Percent of Possible Sunshine (APPS)  
 Obtained from NOAA - National Climatic Data  
 Center (www.ncdc.noaa.gov)  
 APPS Gathered at Blue Hill Observatory in  
 Milton, MA (Data Span 1896-2009)



Map: Georef Alternate Site Sat Image , Print scale 1:25,000, Map center UTM WGS 84 Zone: 18 East: 662,920 North: 4,676,710

Isolines showing shadow in Hours per year, real case



**SHADOW -  
 Map**

**Calculation:**  
 Otis Shadow Flicker - Algeria Rd. REAL CASE  
**WTG:**  
 1 - GE 1.7 103m Rotor 80m Hub

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